# Diversions

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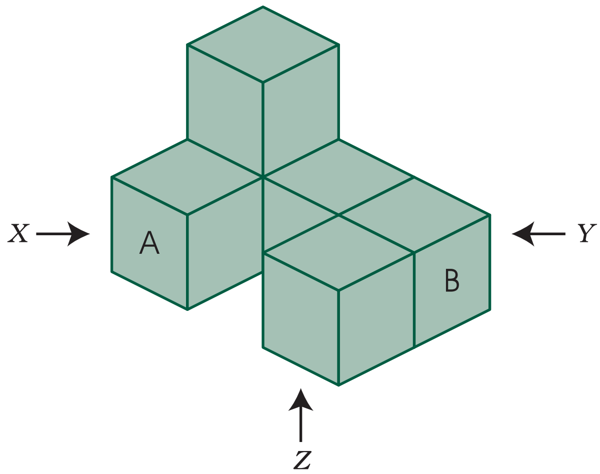
## Spatial thinking tasks — Cube diagrams and drawings

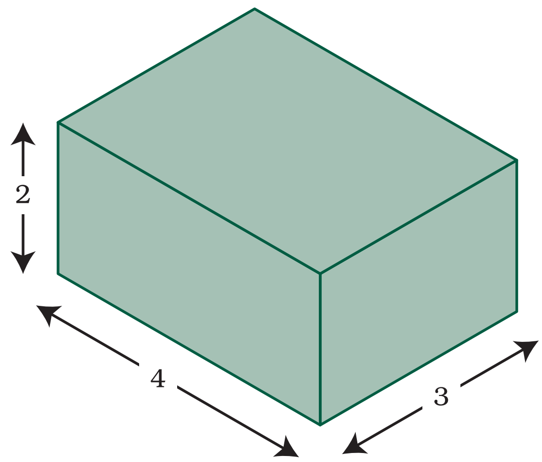
We are looking at five identical cubes, from position *Z*.




1. Draw the diagram, looking from position *Z*, with cube *B* removed.
2. Draw the diagram, looking from position *Z*, with an extra cube on cube *B*.
3. Draw the diagram, from position *Z*, with cube *A* removed.
4. Draw the diagram looking from position *X*.
5. Draw the diagram looking from position *Y*.

This pentacube diagram is based on the principle that a vertical cube-edge is shown 'vertically' on the page. But horizontal edges in the two major directions being used are shown on the page as line-segments drawn at an angle of 30 degrees (approximately, in this drawing) to the horizontal.

The special feature of this way of drawing is that cube-edges appear equally long in the three major directions that they are shown. That is, the edges of a 2 unit × 3 unit × 4 unit 'brick' can be represented by a vertical-on-paper edge of 2 units, a 3 unit line segment in one direction for the width, and a 4 unit line segment for the length.




6. Draw the corresponding diagram if the 2 × 3 face is the 'floor' or base of the rectangular brick; and
7. Draw the corresponding diagram if the 4 × 2 face is the 'floor' or base of the rectangular brick.

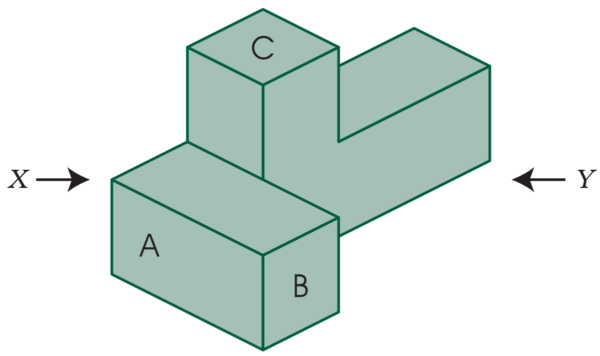
As long as we only measure lines in the diagram in the three major directions, which are at right angles to each other, or 'mutually perpendicular,' we can use the same units of measurement. Such diagrams are called 'isometric,' meaning 'measuring equally' (like the term 'isobars' in weather charts, showing lines of points where air pressure is barometrically equal).

These tasks may be easier if you use:

- actual cubes
- you get down low on the table and look towards the cubes
- you use isometric dotty paper, or isometric grid paper.

Geoff Giles (1979) popularised this kind of spatial thinking task involving modelling, drawing, changing the model, and/or changing the point of view.

Consider this diagram of a shape made with congruent cubes.




Assume there are no hidden holes, no extra blocks at the back of the object.

8. How many cubes make the shape in this diagram?
9. Use the diagram to draw architects' plans of the diagram from:
   (a) a bird's-eye view;
   (b) the side view; and
   (c) the front view.
10. Use actual cubes to create the object represented by the diagram.
11. Draw a diagram to show what we are left with if we remove the cube whose front face is labeled *B*.
12. Draw the result of removing the cube whose upper face is labeled *C*.
13. Draw the result of placing another cube behind the *B*-cube, and below and in front of the *C*-cube.
14. Use the isometric technique to draw the six-cubed object as though you were viewing it from the position labelled *X*, so that the left-hand vertical edge of the face labelled *A* is now the closest vertical edge to the viewer?
15. Use the isometric technique to draw the six-cubed object from position *Y*.
16. Imagine if this object were rotated upwards from the right-back, so that it comes to stand on face *A*. Draw a diagram that shows the result of this change.
17. What if the object is lifted up and tilted backwards or toppled towards the left so that the face labelled *B* becomes the uppermost 'roof.' Draw the object now.

We can extend this kind of isometric drawing to include triangular wedges that are made by slicing single cubes, bi-cubes, tri-cubes, and so on.

## Reference

Giles, G. (1979). *DIME mathematical aids*. Edinburgh, UK: Oliver & Boyd.

From Helen Prochazka's

**Scrapbook**

### Maths and the Atom Bomb

Stanislaw Ulam (1909–1984) was a Polish mathematician who participated in the Manhattan Project and proposed the Teller–Ulam design of thermonuclear weapons.

David Bergamini wrote in "Life Science Library of Mathematics" (1963):

From the inception of the atomic age, mathematicians have been as deeply involved in nuclear physics as physicists themselves. This remains true today, even though machines now do much work formerly done by human experts. The several hundred mathematicians recruited for the wartime Los Alamos project to develop the atomic bomb had at their disposal just one IBM machine, a rudimentary prototype of later computers. With a modern high-speed computer, their work could have been done in less than a hundredth of the time it actually took.

Yet in the post war project to develop the H-bombs, Dr Stanislaw Ulam proved a match for the "thinking machines". A host of calculations had to be made to decide whether the bomb was feasible. The data was given to a team working with the computer ENIAC — and also to Dr Ulam. Doing calculations the long, old fashioned way, Ulam and one assistant turned in their answers before the instructions to ENIAC had been completed. These figures disproved the first theories about the bomb, but Ulam came up with an approach that worked.

His triumph over ENIAC led Dr Edward Teller, head of the project, to remark later: "In an emergency, the mathematician still wins — if he is really good."